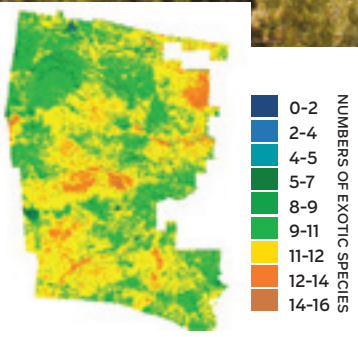
Defending The Front

Invasive species are swift, prolific and headed our way. Scientists hope to stay one step ahead of them.

BY JENNIFER BOGO



GROWING LIKE A WEED

Saltcedar, or tamarisk, chokes the riverbeds of Rocky Mountain National Park, but land managers have limited resources to find and fight it. A predictive map of the park (left) shows where conditions are ripe for weeds to flourish; orange and brown areas would be the hardest hit.

What do saltcedar, fire ants and West Nile virus have in common? No respect for borders. Saltcedar, a Eurasian shrub, lines nearly every streambed in the Western United States, tapping into water tables and acting as tinder for a burn. Red imported fire ants from South America march across the Southern United States and Puerto Rico, snuffing out small animals, damaging crops and short-circuiting electrical systems along the way. West Nile virus, first detected in Africa, has now spread through 48 states, seven Canadian provinces and Mexico, killing more than 500 people and millions of birds. These invasive species were brought here from other countries, either accidentally or intentionally, along with 50,000 other species of plants, animals and pathogens.

"Trying to predict where organisms move in space and time is the premier challenge of the 21st century," says Tom Stohlgren, director of the National Institute of Invasive Species Science at the U.S. Geological Survey (USGS). "It's going to take our very best science." Building upon what has become a full-scale federal battle against the unwanted immigrants, the USGS and the National Aeronautics and Space Administration (NASA) have joined forces to create an Invasive Species Forecasting System—an ambitious project to stop exotics before they steamroll natural ecosystems.

It won't be easy. More invasives arrive every day. Globalization has increased travel, trade and, in turn, the international transport of harmful species. "It's like Darwin on steroids," says Stohlgren. "Except that the *Beagle* is coming to us."

Not all introduced species cause problems—99 percent of U.S. food crops originated elsewhere, for instance—but roughly 15 percent wreak astounding economic and ecological havoc. Fisheries, agriculture and public health have suffered from their proliferation, as have native plants and animals. Invasives cost the United States $137 billion a year, more than all other natural disasters combined. They're also partially responsible for 40 percent of the country's extinctions, and 42 percent of species considered federally threatened and endangered.

Forced to fill the role of these species' absent natural enemies, land and water managers have resorted to just about everything that comes to mind. To control leafy spurge, a water-thirsty weed that has spread across 35 states, they've tried mowing, burning and plowing it; they have treated it with herbicides, and unleashed upon it hordes of insects, goats and sheep. On the East Coast, they've tried fencing, trapping and poisoning European green crabs, which prey on native crabs and oysters, and have subjected zebra mussels, which clog water filtration and electric generating plants, to chlorination, shock treatment and ultraviolet light. The Louisiana Department of Wildlife and Fisheries has even suggested that people

PHOTOGRAPHS BY NASA GODDARD SPACE FLIGHT CENTER (ROCKY MOUNTAIN NATIONAL PARK), U.S GEOLOGICAL SURVEY EROS DATA CENTER (MAP)

eat away at its nutria problem; it touts the aquatic rodent, which has denuded more than 80,000 acres of marsh, as a tasty, low-fat meat.

But don't run for your barbecue just yet. At long last, there's a new, more formidable weapon in the stewardship arsenal: satellite telemetry and supercomputers.

TEAM TECH

Charged with studying invasive species on federal lands, the USGS, at its Fort Collins Science Center in Colorado, excels at the down-and-dirty work of field sampling. NASA, through its Office of Earth Science, brings to the table expertise in remote sensing. Predictive computer models will integrate both kinds of data—ground measurements and satellite observations—and map patterns of invasive species and habitats vulnerable to invasion. Natural resource managers will use this information to decide what fronts to defend first.

A prototype of the new Invasive Species Forecasting System is now being tested at three sites, including Rocky Mountain National Park. More than 100 different invasive species have silently overtaken this spectacular 265,770-acre treasure. In order to gauge where these species tend to cluster, USGS field teams set up 150 plots across 24 different habitats, and recorded the plant communities found in each.

They discovered that wet meadows and aspen stands are the choice real estate. But because field data samples only a fraction of the land, remote sensing must extrapolate it to the big picture. As a general rule, plants prefer the good life—high light, high nitrogen and high moisture—so by measuring biological productivity, or chlorophyll levels, NASA's Landsat 7 and Terra satellites identify potential hot spots for invasion across the entire national park.

That's an oversimplification, of course. Factors such as elevation, soil composition, carbon storage and topography are also important predictors of vulnerable habitats, and all that data requires high-performance computing to crunch. Predictive models used to take the USGS three weeks to run. (During that time period, one kudzu vine—a Japanese import that covers 7 million acres of Southern land and infrastructure—could have crept another 21 ft.) Since NASA introduced state-of-the-art Apple G5 XServe clusters and parallel processing, the modeling time is down to a mere 2 minutes.

"Information science and technology are going to play an ever-more important role in dealing with complex ecological problems," says John Schnase, program scientist for NASA's Invasive Species National Application. And because invasive species change an ecosystem's fire cycle, hydrology and ability to store carbon, understanding how species move across a landscape will help refine computer models that forecast climate change and disease outbreaks, too.

As for the current ground war, USGS and NASA scientists plan to apply the forecasting system to habitats across the rest of the country, and to expand its focus from plants to insects, animals, fish, fungi and microbes. Eventually, an online tool will produce maps for preserve and park managers, and offer the public a glimpse of what organisms are heading their way. With everyone aware of invasive species' next move, they'll have a far more difficult time making it. PM